NUMBER SYSTEM

Number system is a basis for counting varies items. Modern computers communicate and operate with binary numbers which use only the digits 0 &1. Basic number system used by humans is Decimal number system.

For Ex: Let us consider decimal number 18. This number is represented in binary as 10010.

We observe that binary number system take more digits to represent the decimal number. For large numbers we have to deal with very large binary strings. So this fact gave rise to three new number systems.

i) Octal number systems

ii) Hexa Decimal number system

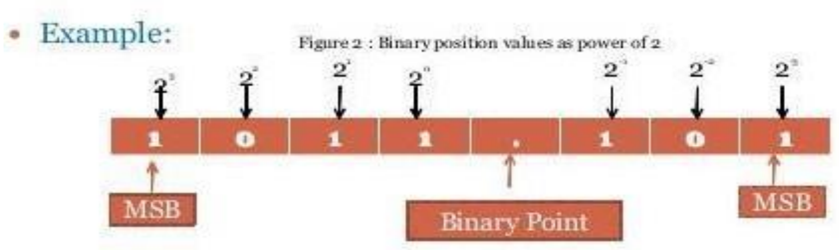
iii) Binary Coded Decimal number(BCD) system

To define any number system we have to specify

- Base of the number system such as 2,8,10 or 16.
- The base decides the total number of digits available in that number system.
- First digit in the number system is always zero and last digit in the number system is always base-1.

Binary number system:

The binary number has a radix of 2. As r = 2, only two digits are needed, and these are 0 and 1. In binary system weight is expressed as power of 2.



The left most bit, which has the greatest weight is called the Most Significant Bit (MSB). And the right most bit which has the least weight is called Least Significant Bit (LSB).

For Ex: $\mathbf{1001.01_2 = [\ (1) \times 2^3\ ] + [\ (0) \times 2^2\ ] + [\ (0) \times 2^1\ ] + [\ (1) \times 2^0\ ] + [\ (0) \times 2^{-1}\ ] + [\ (1) \times 2^2\ ]}$

$\mathbf{1001.01_2 = [\ 1 \times 8\ ] + [\ 0 \times 4\ ] + [\ 0 \times 2\ ] + [\ 1 \times 1\ ] + [\ 0 \times 0.5\ ] + [\ 1 \times 0.25\ ]}$

$\mathbf{1001.01_2 = 9.25_{10}}$

Decimal Number system

The decimal system has ten symbols: 0,1,2,3,4,5,6,7,8,9. In other words, it has a base of 10.

Octal Number System

Digital systems operate only on binary numbers. Since binary numbers are often very long, two shorthand notations, octal and hexadecimal, are used for representing large binary numbers. Octal systems use a base or radix of 8. It uses first eight digits of decimal number system. Thus it has digits from 0 to 7.

Hexa Decimal Number System

The hexadecimal numbering system has a base of 16. There are 16 symbols. The decimal digits 0 to 9 are used as the first ten digits as in the decimal system, followed by the letters A, B, C, D, E and F, which represent the values 10, 11,12,13,14 and 15 respectively.

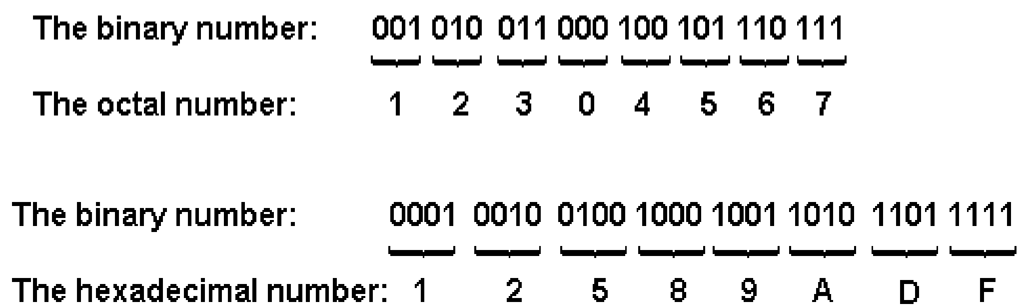
Decimal	Binary	Octal	Hexadecimal
0	0000	0	0
1	0001	1	1
2	0010	2	2
3	0011	3	3
4	0100	4	4
5	0101	5	5
6	0110	6	6
7	0111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F

Number Base conversions

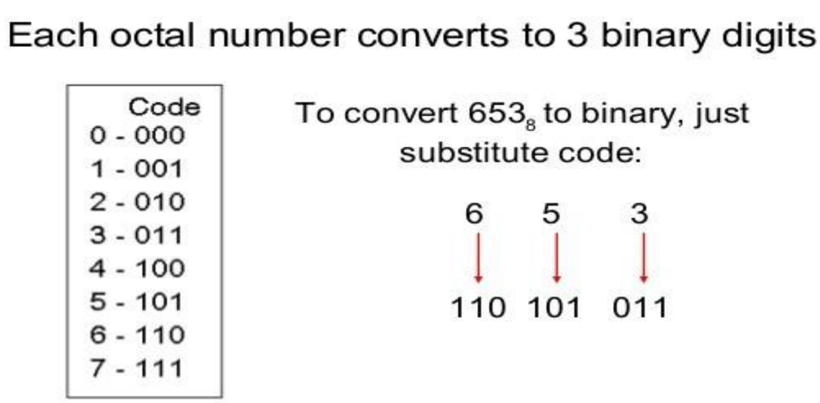
The human beings use decimal number system while computer uses binary number system. Therefore it is necessary to convert decimal number system into its equivalent binary.

i) Binary to octal number conversion

ii) Binary to hexa decimal number conversion



iii) Octal to binary Conversion



iv) Hexa to binary conversion

v) Octal to Decimal conversion

Ex: convert 4057.06_8 to octal

$=4x8^3+0x8^2+5x8^1+7x8^0+0x8^{-1}+6x8^{-2}$

$=2048+0+40+7+0+0.0937$

$=2095.0937_{10}$

vi) Decimal to Octal Conversion

Ex: convert 378.93_{10} to octal

378_{10} to octal: Successive division:

```
 8 |  378
   |_____
8 |47 ---    2
   |_________
8 |5  ---    7        ↑
   |________
    0   ---    5
```

$=572_8$

0.93_{10} to octal :

0.93x8=7.44

0.44x8=3.52 ↓

0.53x8=4.16

0.16x8=1.28

$=0.7341_8$

$378.93_{10}=572.7341_8$

vii) Hexadecimal to Decimal Conversion

Ex: $5C7_{16}$ to decimal

$=(5x16^2)+(C\ x16^1)+ (7\ x16^0)$

=1280+192+7

$=147_{10}$

viii) Decimal to Hexadecimal Conversion

Ex: 2598.67510

```
 1 6 |2598
     |______
16 16|2          -6
      10          -2
```

= $A26_{(16)}$

0.67510=0.675x16 -- 10.8

=0.800x16 -- 12.8 ↓

=0.800x16 -- 12.8

=0.800x16 -- 12.8

=0.ACCC$_{16}$

2598.675$_{10}$ = A26.ACCC$_{16}$

ix) Octal to hexadecimal conversion:

The simplest way is to first convert the given octal no. to binary & then the binary no. to hexadecimal.

Ex: 756.603$_8$

7	5	6	.	6	0	3
111	101	110	.	110	000	011
0001	1110	1110	.	1100	0001	1000
1	E	E	.	C	1	8

x) Hexadecimal to octal conversion:

First convert the given hexadecimal no. to binary & then the binary no. to octal.

Ex: B9F.AE16

B	9	F	.	A	E		
1011	1001	1111	.	1010	1110		
101	110	011	111	.	101	011	100
5	6	3	7	.	5	3	4

=5637.534

Complements:

In digital computers to simplify the subtraction operation & for logical manipulation complements are used. There are two types of complements used in each radix system.

i) The radix complement or r's complement
ii) The diminished radix complement or (r-1)'s complement